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Technology: Transforming the Finance Function and the Competencies Management Accountants Need

By Frans Roozen, Ph.D.; Bert Steens, Ph.D.; and Louis Spoor

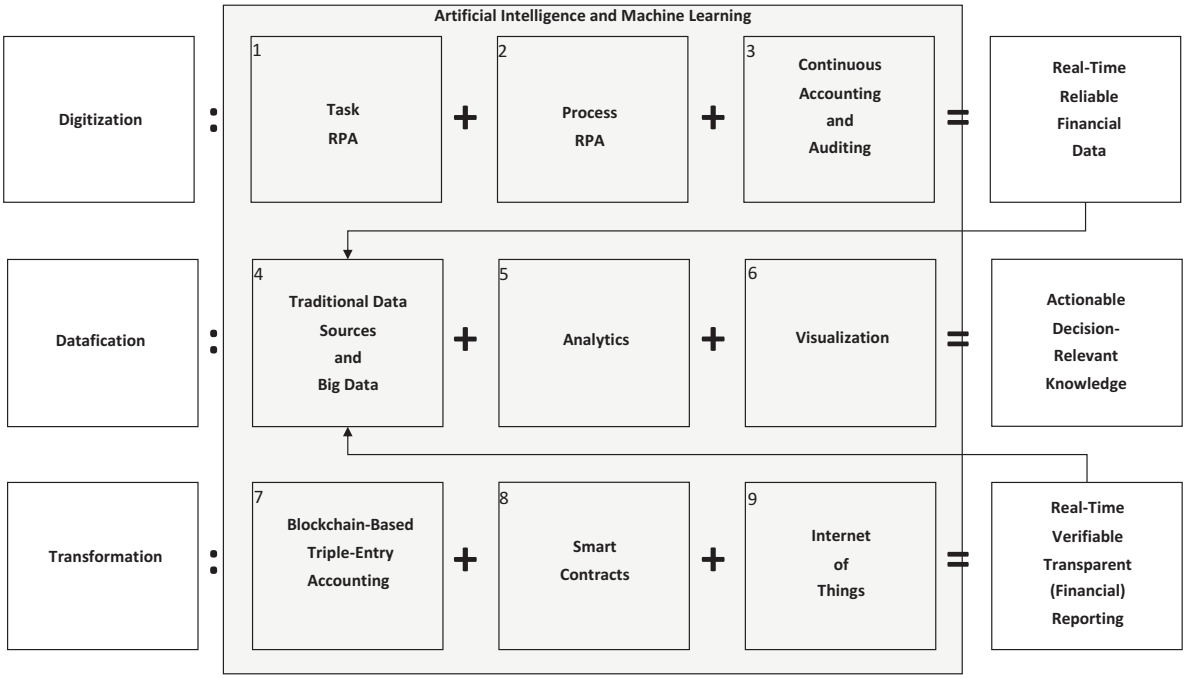
EXECUTIVE SUMMARY

The rapidly increasing impact of digital technologies on the finance function requires new competencies from finance professionals. Based on the findings of a survey of 60 senior finance professionals from leading companies, this study proposes a framework for developing these competencies. The outcomes of the study support the development of the digital agenda of the finance function and the requirements for management accountants.

Technological innovations and ongoing digitization have far-reaching consequences that will likely affect every organization—and the finance function and management accountants in particular—over the next few years. Ongoing technological developments will continue to increase the amount and variety of data and accelerate the speed at which data becomes available.[1] Organizations need to transform to remain relevant and come out on top of the current digital revolution.

Articles have regularly signaled the enormous impact of technological innovations on finance. They predict that innovations such as cloud computing, robotics (robotic process automation or RPA), machine learning, artificial intelligence (AI), the Internet of Things (IoT), Big Data, and distributed data processing and recording (blockchain) will drastically change the finance function and place new demands on the management accountant. Because of this and the context-specific meaning that users assign to data, organizations and particularly the finance function have to consider the ways this data from internal and also external data sources is collected, recorded, processed, saved, and distributed within and between organizations to ensure that they fully benefit from the

Figure 1: Framework of Technology-Driven Innovations



available data. After all, the availability of more, alternative, diverse, and multiform data may complement and improve the quality of performance management and decision making within the specific context relevant to the organization(s) involved. To do so, these technological developments will enable management accountants and other business professionals to deploy their organization's automated systems with end-user analytics tools.

CFOs need to adequately anticipate and manage the impact of technological developments and the consequences for the required competencies. In this article, we establish a framework that classifies the technological developments into three areas: digitization (referring to technologies that digitize and automate accounting information processes, such as RPA), datafication (covering technologies that capture, analyze, evaluate, and valorize data about performance and its drivers, such as data analytics), and transformation (pointing at technologies that significantly impact and boost digitization and datafication, such as IoT). We explain how they individually and collectively influence the finance function and what competencies the finance function needs. To learn about the competencies, we surveyed 60 senior finance professionals from leading organizations. The framework, combined with the survey results, can serve as a starting point—essentially a self-assessment—for developing the digital agenda of the finance function and the requirements for management accountants.

FRAMEWORK OF TECHNOLOGY-DRIVEN INNOVATIONS

Our framework focuses on the typical areas for which management accountants are responsible: finance operations (transaction processing), financial planning and analysis, and business control. Roughly put, technological innovation can influence the finance function in two ways: ongoing automation of transaction processing through RPA, machine learning, AI, and blockchain, and the enormous increase of data available to support performance evaluation and decision making. In terms of a timeline, blockchain, which could ultimately have the greatest influence, will take the longest to acquire a visible and permanent place in organizations.[2] Pioneering organizations are already implementing other technological innovations, such as Big Data, that are expected to become mainstream within three to five years.

Since adapting could take years, the finance function should develop a vision that looks at the short- and long-term impact. To help develop this vision, we structured technological developments in three workflows: digitization, datafication, and transformation. Figure 1 displays each and their building blocks.

Digitization of the Finance Function

Digitization automates repetitive transaction processing tasks such as entering expense claims to reconciling bank data. Using algorithms, the robot, which in this case is computer software, completes a series of tasks according to fixed rules, such as retrieving and processing data and transferring it to another system. In principle, robots can carry out all tasks that can be described with fixed rules.[3]

In 2015, the Association of Chartered Certified Accountants (ACCA) published *The robots are coming?* which asks whether RPA forms a threat for organizations that use business process outsourcing (BPO) solutions.[4] Some suggest that signing a five- to 10-year BPO contract amounts to foregoing significant benefits of RPA during that period, while others believe the technology is unlikely to develop that rapidly. The May and November 2017 editions of *Strategic Finance* suggested that RPA involves much more than automating individual tasks and processes, and that it forms the foundation of continuous accounting.[5] Powered by RPA, continuous accounting has the potential to improve the finance function's efficiency and effectiveness. This is reason enough to zoom in on the digitization stage first.

RPA affects efficiency by making it possible to supply financial data in real time because the data can be processed automatically. This enables the finance function to produce, verify, and analyze reports on a continuous basis without having to make any substantial changes to the accounting processes. At the same time, having access to financial data such as balance sheet details on a real-time basis allows the finance function to provide much more effective support to management decision making.

RPA applications are not limited to separately defined tasks but can also include integrated (end-to-end) processes. These could be separate accounting cycles such as purchase-to-pay or periodic closing processes such as record-to-report. Process-based RPA is not only highly complex—the automation of all tasks in a process—but in practice also involves a larger number of exceptions (i.e., deviations from the fixed rules).

RPA combined with AI replaces human labor with electronic labor. Applying AI makes it possible to automate integrated processes while at the same time learning from exceptions (the computer automatically changes the instructions to respond to the exception). Thus a labor-intensive process that for this reason is postponed until the end of the reporting period is taken over by complex, semi-self-learning computer programs that are based on algorithms that can process huge quantities of data, transactions, tasks, and exceptions in a very short period of time and practically without human intervention.[6] When combined with continuous accounting principles, this makes it possible to not only carry out the end-of-period processes automatically but also on a daily basis.[7]

Datafication of the Finance Function

Digitization is making organizations increasingly data-driven, whereby alongside internal data, external data has been gaining increasing importance, fueling the acceleration of the use of data analytics and smart visualization for improving the quality of decision making. The huge increase in external data is largely due to the internet as a distribution channel and the increasing application of technological innovations, including sensors and radio-frequency identification (RFID) on products to link them to the virtual environment through the internet, using IoT, a global network of machines and devices capable of interacting with each other.[8] To a large extent, our behavior is already being expressed in data, and the internet has established a vast network of highly connected human actors and other active data processing and generating sources with far-reaching consequences. Companies are increasingly becoming giant data machines, and today datafication is one of the most important IT developments.[9]

Technological innovations in data sources are not only resulting in enormous quantities of new data, but this data is also rapidly becoming much more accessible and available in real time. This means that the basis for decision making is changing, too.[10] A few decades ago, the source of all formal information was primarily the aggregated financial report. As more and more detailed information became available, financial information was supplemented with nonfinancial information, resulting in increasingly thicker reports. In more recent times, concepts like the balanced scorecard turned the use of information upside down. The realization dawned that

financial information is primarily retrospective and that well-designed scorecards can provide clearer and earlier insight into factors that influence the organization's future performance, rendering periodic financial reports less and less useful as a tool for decision making.

In addition to the increasing importance of early access to nonfinancial data, technological developments increasingly offered seemingly unlimited access to drill-down longitudinal and cross-sectional data. The extensive rollout of enterprise resource planning (ERP) systems enriched organizations with vast volumes of current and historical data. Along with the increasing capabilities of IT systems, this led to preprogrammed digital reports being discarded in favor of ad hoc formulated queries of primary data, as these facilitate real-time support for decision making and performance analyses.

In summary, the increasing availability, timeliness, and accessibility of real-time information means companies are using both paper and preprogrammed digital reports less and less. It is no surprise that the tried and trusted system of periodic management reporting has now become part of automated and/or outsourced transaction processing systems.[11]

In addition to internal data, more and more external data is becoming available to support business decision making. Big Data is also playing an increasingly important role in decision making.[12] This category of data cannot be adequately processed and analyzed by traditional information systems.[13] Furthermore, the data is often spread across several data sets that are too large for regular database management systems to store.[14]

Converting Big Data into insights and knowledge that are relevant to decision making demands the adequate use of analytics. Traditional statistical analyses for explanatory, predictive, and prescriptive analytics need to be geared up for enabling machine learning based on AI and for dealing with the high volume, high velocity, and high variety of data that define the phenomenon of Big Data.[15] This requires much more than simply deploying analytics.

First and foremost, the organization must have the capacity to deal with extremely large amounts of structured and unstructured data spread over multiple data sets. Finance must understand, manage, and process huge data sets extremely quickly from a wide range of sources if it is to benefit from Big Data (for example, to prepare forecasts—and to ultimately stay relevant).[16] The finance function must not only acquire analytical skills but also a different attitude. While it is inclined to focus on accuracy and reliability, such a limited view of the world of datafication will prove unsustainable.[17]

Transforming the Work of the Finance Function

In the article "The Truth about Blockchain," Marco Iansiti and Karim R. Lakhani describe what they think the future of blockchain holds for businesses:

> "Contracts, transactions, and the records of them are among the defining structures in our economic, legal, and political systems. They protect assets and set organizational boundaries. They establish and verify identities and chronicle events. They govern interactions among nations, organizations, communities, and individuals. They guide managerial and social action. And yet the critical tools and bureaucracies formed to manage them have not kept up with the economy's digital transformation.…In a digital world, the way we regulate and maintain administrative control has to change. Blockchain promises to solve this problem."[18]

Put simply, blockchain enables users to register transactions in a digital record. Every transaction is time-stamped and linked to the previous transaction using a cryptographically encrypted algorithm. The data records of all the participating users are replicated and synchronized on the nodes (i.e., computers) in the user network. The result is a distributed network of data records that share a special characteristic: Once recorded, it is impossible to forge or delete a transaction without the other users noticing this.

One might well assume that the financial accounts of the world's most innovative companies have already been converted to blockchain, and that the blockchain as a distributed ledger, i.e., a universal ledger that is shared with other stakeholders, suggests a strong relationship with the finance function. The reality, however, is different. Currently, blockchain is mainly being tested in various proof-of-concept projects that involve organizational processes other than accounting.[19] Examples include payment systems, value chain management, supply chain management, and insurance policies. Significant devel-

opments in blockchain applications have primarily been made in combination with smart contracts.[20] Others are in the interconnections between physical and virtual environments using intermediate products and/or by fitting products with sensors of an IoT application.[21] In addition to recording contracts and transactions, smart contracts can also provide technology to initiate and execute confirmed contracts autonomously.

The finance function is still for the most part considering how to use blockchain systems for accounting purposes. *The Journal of Information Systems* provides an extensive example.[22]

The increasing digital interaction between partners in the value chain and stakeholders such as banks and regulators—but also the increasing evolution of products into intelligent and connected instruments—are radically changing both the processes and structures of organizations.[23] This will clearly influence the traditional organization-specific accounting ecosystems. An accounting ecosystem is a system of connected accounting systems of parties involved in common value chains. These parties can be, for example, divisions of a company, two companies of a joint venture, or several construction companies working on an infrastructural project. Traditional accounting ecosystems are typically organization-specific, i.e., tailored for the needs of a specific organization. It is not hard to predict that the traditional accounting ecosystems will be replaced altogether once technologies that enable digital interaction within and between value chains are implemented and support any type of cooperation between parties in existing and new value chains. More and more stakeholders believe this will combine extensive applications of end-to-end processes focused on RPA and AI and a form of distributed data recording, albeit initially between only a limited group of parties.[24]

Blockchain, however, will not be adopted overnight.[25] It is more likely that the adoption process will slowly but surely take form and eventually mark the end of the current practice of recording economic transactions.[26] The blockchain itself is a system for recording all transactions that potentially makes significant parts of the traditional company-specific transaction processes redundant.[27]

The transformation will have consequences for the management of companies and, in particular, the extent to which management instruments are fit for the future. RPA and AI will replace human labor, but blockchain promises to allow parties in the value chain to cooperate seamlessly through the distributed ledger concept, so that the practice of recording transactions as part of accounting cycles will disappear altogether. This raises the question of whether certain concepts will remain valid, such as those that underlie accounting and management information provision, and hence form the foundation of the organization and implementation of finance operations.[28]

In time, these developments are expected to transform finance operations from one of managing the integrity and reliability of transaction processing to an aggregation and code validation function, whereby instead of prints or PDF files, smart contracts will be used—pieces of code that enable the controller to express debit and credit in smart contract terms. This will undeniably require sound accounting knowledge, but if the current accounting processes cease to exist or are merged into the blockchain environment, this will also redefine the financial and management accounting functions.[29]

VOICE OF SENIOR FINANCIAL PROFESSIONALS

On June 14, 2018, 60 senior financial professionals shared their opinion on the framework topics by anonymously completing our survey on their smartphones. The results appeared in real time.[30] The participants comprised 32 senior executives in finance, control, and accounting with titles such as CFO, finance director, and controller; 21 senior advisors with titles such as partner and manager; and seven other senior finance professionals and experts with titles such as tax director and professor. They represent primarily large and medium international enterprises operating in industries from food and beverages to consumer products to high tech to education and others. Their views provide management accountants with a relevant perspective for personal competency development purposes.

As an introduction, we explained the framework in Figure 1 and asked participants about their views on the three most important finance tasks in 2022. The results confirm the business partner role will gain in im-

portance as participants most often mentioned that the following areas will increase in importance in 2022: analysis and predictive analytics, business control, business support and decision support, and strategy.

Participants also gave their opinions on what three areas will decrease the most as far as required human capacity. Most of the votes regarding the declining functional areas went to audit, accounting, manual transactions, registration, and data processing.

After the introduction, we asked the participants to respond to questions by submitting their scores that express their view on the extent of hype of financial analytics (question 1, used to control for bias, is further explained in endnote 29), the activities driving the finance function (question 2), and their current and future competency level (questions 3 to 10). Question 2 asked about the extent to which financial planning and analysis (FP&A), business control (BC) and finance operations (FinOps) activities are considered to determine the agenda of finance functions directly working for the business.

Therefore, we focused on the decentral FP&A, BC, and FinOps activities for operating units, business units, divisions, etc., and not on central group activities, for instance, holding-related regulatory tasks. Questions 3 to 10 asked about the participants' current competence level and the competence level required from them in 2022 for the following nine technical developments captured by our framework: RPA, continuous accounting, AI and machine learning (relevant for all building blocks), Big Data, analytics, visualization, blockchain and smart contracts, and IoT. The questions distinguished between three competency categories: competencies required to inspire others (inspirational competencies), finance-related competencies required to initiate and manage developments relevant for the finance function (functional competencies), and technical skills required for applying the building blocks to the benefit of the finance function (technical competencies). Participants submitted their scores on a 1 to 5 Likert scale (1 = not needed, 2 = initial, 3 = basic, 4 = advanced, 5 = leading) for each area.

Descriptives and Data Quality

Table 1 summarizes the descriptive statistics of the responses for each question. Each question is represented by a variable with the variable names printed in italics.

Table 1 reveals that the number of valid responses to the questions ranges from 39 (65%) to 46 (77%), so the sample is sufficiently large to be representative for the population, as the sample corresponds with an error margin of between 0.02 and 0.04 for the continuous scales and an error margin that ranges from 0.03 to 0.15 for the discrete variables (Likert scales) at a confidence level of 95%.[31]

Data Analysis

For each variable, we compared the observations for 2022 with those during 2018 in order to establish whether the participants assume significant changes. We also analyzed whether the observations are different for the three competency categories (inspirational, functional, and technical) and for the three functional areas (FinOps, FP&A, and BC). For these comparisons, we used parametric and nonparametric statistical tests.[32]

We checked whether individual positions on the extent of hype affected the responses and found that this is not the case, meaning that the outcomes are representative for our group of respondents.[33]

SURVEY RESULTS

Table 2 shows the statistical significance of the differences between the outcomes for 2022 and those for 2018 for all competency-related and functional area-related variables. Figure 2 graphically presents the means of all competency-related variables for 2018 and 2022. These two show the following results relating to the development of the functional areas:

- The importance of finance operations is expected to decrease significantly, while the importance of FP&A and BC is expected to increase (the significance of this finding corresponds with a confidence level of at least 95%).
- In 2022, FinOps is expected to determine the finance agenda for just under 15% as opposed to almost 40% now. Participants believe that FP&A will claim 38.3% of the finance agenda in 2022, which is more than 10% higher than in 2018.
- The assumed importance of BC grows from almost 29% to a solid one-third in 2022.

Table 1: Descriptive Statistics

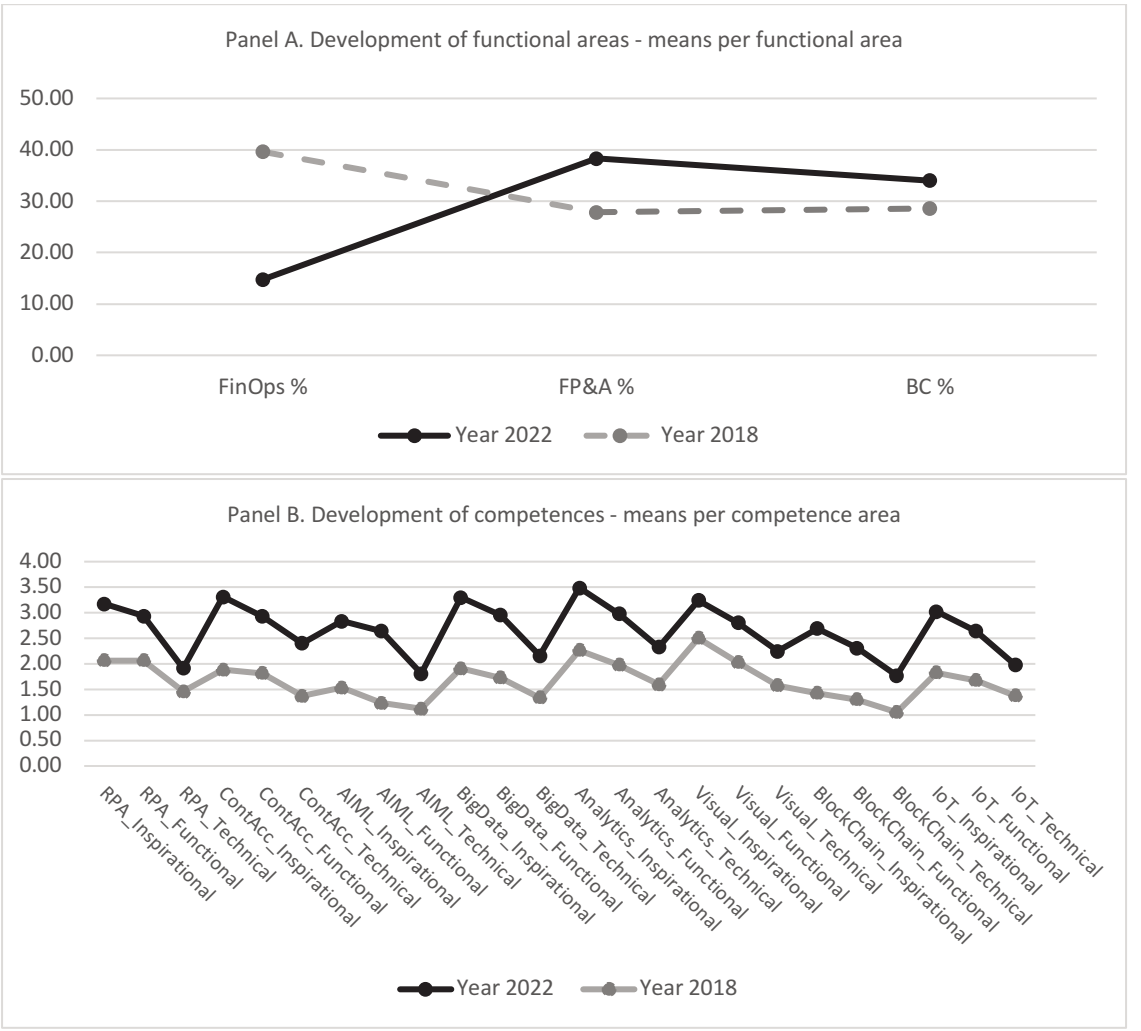
Question i	Variable i	Valid N_i	Mean μ_i	Median	Std. Dev.	Skewness	Kurtosis	Min	Max
1	*FadClass*	43	3.40	3	1.85	0.61	-0.13	1	8
2a	*FFdriver_FinOps_2022*	45	14.78	10	15.95	1.83	2.84	0	60
2b	*FFdriver_FP&A_2022*	45	38.33	40	18.77	-0.18	0.36	0	80
2c	*FFdriver_BC_2022*	45	34.00	40	19.59	-0.44	-0.89	0	60
2d	*FFdriver_FinOps_2018*	43	39.60	40	18.22	0.38	2.21	0	100
2e	*FFdriver_FP&A_2018*	43	27.86	30	13.88	0.58	1.79	0	70
2f	*FFdriver_BC_2018*	43	28.58	30	15.28	0.80	2.07	0	80
3a	*RPA_Inspirational_2022*	46	3.17	3	0.93	-0.89	-0.10	1	4
3b	*RPA_Functional_2022*	46	2.94	3	0.71	-0.29	0.08	1	4
3c	*RPA_Technical_2022*	46	1.91	2	0.76	0.47	-0.10	1	4
3d	*RPA_Inspirational_2018*	46	2.07	2	0.90	0.43	-0.61	1	4
3e	*RPA_Functional_2018*	46	2.07	2	0.90	0.62	-0.22	1	4
3f	*RPA_Technical_2018*	46	1.46	1	0.69	1.65	3.03	1	4
4a	*ContAcc_Inspirational_2022*	42	3.31	3	0.75	-0.95	0.79	1	4
4b	*ContAcc_Functional_2022*	42	2.93	3	0.81	-0.45	-0.09	1	4
4c	*ContAcc_Technical_2022*	42	2.41	2	0.96	0.11	-0.88	1	4
4d	*ContAcc_Inspirational_2018*	43	1.88	2	0.79	0.21	-1.36	1	3
4e	*ContAcc_Functional_2018*	43	1.81	2	0.88	0.82	-0.12	1	4
4f	*ContAcc_Technical_2018*	43	1.37	1	0.62	2.10	6.23	1	4
5a	*AIML_Inspirational_2022*	42	2.83	3	0.79	0.01	-0.76	1	4
5b	*AIML_Functional_2022*	42	2.64	3	0.73	-0.13	-0.09	1	4
5c	*AIML_Technical_2022*	42	1.81	2	0.77	0.35	-1.22	1	3
5d	*AIML_Inspirational_2018*	43	1.54	1	0.70	1.39	2.30	1	4
5e	*AIML_Functional_2018*	43	1.23	1	0.43	1.31	-0.29	1	2
5f	*AIML_Technical_2018*	43	1.12	1	0.50	5.11	28.19	1	4
6a	*BigData_Inspirational_2022*	44	3.30	3	0.63	-0.32	-0.60	2	4
6b	*BigData_Functional_2022*	44	2.96	3	0.65	0.04	-0.47	2	4
6c	*BigData_Technical_2022*	44	2.16	2	0.81	0.54	0.17	1	4
6d	*BigData_Inspirational_2018*	44	1.91	2	0.86	0.41	-0.93	1	4
6e	*BigData_Functional_2018*	44	1.73	2	0.59	0.11	-0.44	1	3
6f	*BigData_Technical_2018*	44	1.34	1	0.53	1.19	0.43	1	3
7a	*Analytics_Inspirational_2022*	43	3.49	4	0.70	-1.04	-0.19	2	4
7b	*Analytics_Functional_2022*	43	2.98	3	0.74	-0.33	-0.07	1	4
7c	*Analytics_Technical_2022*	43	2.33	2	0.75	0.10	-0.18	1	4
7d	*Analytics_Inspirational_2018*	42	2.26	2	0.73	0.31	0.12	1	4
7e	*Analytics_Functional_2018*	42	1.98	2	0.56	-0.01	0.42	1	3
7f	*Analytics_Technical_2018*	42	1.60	1.5	0.66	0.68	-0.53	1	3
8a	*Visual_Inspirational_2022*	41	3.24	3	0.80	-0.79	0.01	1	4
8b	*Visual_Functional_2022*	41	2.81	3	0.87	-0.31	-0.49	1	4
8c	*Visual_Technical_2022*	41	2.24	2	0.83	0.06	-0.62	1	4
8d	*Visual_Inspirational_2018*	40	2.50	2	0.91	0.11	-0.69	1	4
8e	*Visual_Functional_2018*	40	2.03	2	0.73	0.37	0.10	1	4
8f	*Visual_Technical_2018*	40	1.58	1	0.75	1.28	1.53	1	4
9a	*Blockchain_Inspirational_2022*	39	2.69	3	0.80	-0.67	0.25	1	4
9b	*Blockchain_Functional_2022*	39	2.31	2	0.83	0.51	-0.06	1	4
9c	*Blockchain_Technical_2022*	39	1.77	2	0.71	0.36	-0.88	1	3
9d	*Blockchain_Inspirational_2018*	40	1.43	1	0.55	0.80	-0.43	1	3
9e	*Blockchain_Functional_2018*	40	1.30	1	0.52	1.48	1.38	1	3
9f	*Blockchain_Technical_2018*	39	1.05	1	0.22	4.23	16.78	1	2
10a	*IoT_Inspirational_2022*	39	3.03	3	0.84	-0.61	-0.06	1	4
10b	*IoT_Functional_2022*	39	2.64	3	0.90	0.12	-0.84	1	4
10c	*IoT_Technical_2022*	39	1.97	2	0.96	0.81	-0.14	1	4
10d	*IoT_Inspirational_2018*	40	1.83	2	0.78	0.66	0.04	1	4
10e	*IoT_Functional_2018*	40	1.68	2	0.69	0.54	-0.75	1	3
10f	*IoT_Technical_2018*	40	1.38	1	0.63	1.48	1.15	1	3

Table 2: Comparison between Responses for 2018 and Responses for 2022

Variable		μ_{2022}	μ_{2018}	$\mu_{2022} - \mu_{2018}$	$p^{\dagger}$	H_0: $\mu_{2022} = \mu_{2018}$
FFdriver	*FinOps*	14.78%	39.61%	-24.83%	<.001***	$\mu_{i2022} < \mu_{2018}$, reject H_0
	FPA	38.33%	27.86%	10.47%	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	BC	34.00%	28.58%	5.42%	=.022**	$\mu_{i2022} > \mu_{2018}$, reject H_0
RPA	*Inspirational*	3.17	2.07	1.10	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Functional	2.94	2.07	0.87	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Technical	1.91	1.46	0.45	=.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
ContAcc	*Inspirational*	3.31	1.88	1.43	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Functional	2.93	1.81	1.12	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Technical	2.41	1.37	1.04	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
AIML	*Inspirational*	2.83	1.54	1.29	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Functional	2.64	1.23	1.41	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Technical	1.81	1.12	0.69	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
Big Data	*Inspirational*	3.30	1.91	1.39	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Functional	2.96	1.73	1.23	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Technical	2.16	1.34	0.82	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
Analytics	*Inspirational*	3.49	2.26	1.23	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Functional	2.98	1.98	1.00	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Technical	2.32	1.60	0.72	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
Visual	*Inspirational*	3.24	2.50	0.74	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Functional	2.81	2.03	0.78	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Technical	2.24	1.58	0.66	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
Blockchain	*Inspirational*	2.69	1.43	1.26	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Functional	2.31	1.30	1.01	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Technical	1.77	1.05	0.72	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
IoT	*Inspirational*	3.03	1.83	1.20	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Functional	2.64	1.68	0.96	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0
	Technical	1.97	1.38	0.59	<.001***	$\mu_{i2022} > \mu_{2018}$, reject H_0

*,**,*** denote 10%, 5%, and 1% significance level, respectively
†: the reported values for p result from applying the Wilcoxon signed rank test for paired observations

Figure 2: Development of Functional Areas and Competencies According to Participants



With regard to the inspirational, functional, and technical competencies relating to the nine technical developments, the results in Figure 2 and Table 2 show the following:

- Participants rate their competency levels in 2018 considerably lower than 3 on the 1 to 5 Likert scale. For the inspirational competencies, the actual means range from 1.43 (blockchain) to 2.50 (visualization). The means for the assumed functional competencies range from 1.23 (AI and machine learning) to 2.07 (RPA). For the technical competencies, the range is the lowest: 1.05 (blockchain) to 1.60 (analytics).
- Their current top three competencies in 2018 are the inspirational competencies in the area of visualization (2.50), analytics (2.26), and RPA (2.07). The average score for functional RPA competencies is also 2.07.
- Two of the three least-developed competencies for 2018 are technical competencies relating to blockchain (1.05), AI and machine learning (1.12), and functional blockchain competencies (1.30).
- The importance of significantly developing all their competencies between 2018 and 2022 is sup-

ported by our participants at a confidence level of at least 99.9%. Interestingly, they responded that current differences between the development levels of the three competency categories will increase between 2018 and 2022. Inspirational competencies, the currently most advanced competency area, is expected to increase the most, while—surprisingly—technical competencies, the currently least developed area, will increase the least.

- The most substantial developments for all competency categories together that will be required in 2022 are AI and machine learning, continuous accounting, and Big Data, while RPA, IoT, and visualization are expected to require the least.
- Their expected competency levels for 2022 exceed the average of 3.0 for most of the inspirational competencies, while the means for the functional competencies fall short of 3.0. The expected means of the inspirational competencies range from 2.69 (blockchain) to 3.49 (analytics), while the expected means of the functional competencies range from 2.31 (blockchain) to 2.98 (analytics). The range for the technical competencies are the lowest at 1.77 (blockchain) to 2.41 (continuous accounting).
- The expected top three most developed competencies in 2022 comprise the inspirational competencies related to analytics (3.49), continuous accounting (3.31), and Big Data (3.30).
- The following competencies are expected to be least developed in 2022: technical blockchain (1.77), technical AI and machine learning (1.81), and technical RPA (1.91).

Table 3 shows additional insights with regard to developing the functional areas and the competencies that can be derived:

- The position of FinOps on the current finance agenda is significantly more important than those of FP&A and BC (significance corresponds with confidence levels of 99.7% and 99.5%, respectively). FP&A and BC have the same levels of perceived importance in 2018, but the importance of both will increase. The position of FinOps on the finance agenda is expected to be significantly lower than the positions of FP&A and BC.
- The inspirational and functional competencies required in 2022 are expected to exceed the required technical competencies in 2022. The inspirational competencies required by participants in 2022 exceed the functional competencies in 2022 except for the areas of AI and machine learning as well as RPA. In 2018 the perceived inspirational and functional competency levels are closer to each other, but the technical competencies are believed to be significantly less developed.

Overall implications include a significant amount of human capacity becoming redundant in FinOps, while the importance of FP&A and BC increases. This begs the question whether this redundancy will be countered by an increase in demand for management accountants in FP&A and BC. If we assume that the technology-driven innovations in Figure 1 not only improve the efficiency of FinOps but also that of FP&A and BC activities, then the increased importance of FP&A and BC could very well result in the hiring of fewer management accountants.

Other outcomes imply that senior finance professionals see for themselves a more inspirational and, to a somewhat lesser extent, a functional role concerning the adoption of technology-driven innovations. As primarily senior finance professionals participated in the survey, we expect that management accountants reporting to them will need to take up the necessary functional and technical competencies for the finance function to contribute to the digital transformation taking place in organizations.

RECOMMENDATIONS FOR THE MANAGEMENT ACCOUNTANT

Briefly put, a management accountant assumes responsibilities for the adequate performance of FinOps, FP&A, and BC. They are already or will soon be faced with more and different technologies that affect these areas—and considerably influence these responsibilities. Senior financial professionals also voiced this in the survey. In fact, as early as 2014, the American Institute of Certified Public Accountants (AICPA) and the American Accounting Association (AAA) were already declaring that technology is increasingly being used to

Table 3: Comparison of Functional Areas and Competence Categories for 2018 and 2022

Variable‡		2022				2018			
		μ_i	μ_j	$p^{\dagger}$	H_0: $\mu_i = \mu_j$	μ_i	μ_j	$p^{\dagger}$	H_0: $\mu_i = \mu_j$
FFdriver	*FinOps* (*i*) – *FP&A* (*j*)	14.78%	38.33%	<.001***	$\mu_i < \mu_j$, reject H_0	39.61%	27.86%	.003***	$\mu_i > \mu_j$, reject H_0
	FinOps (*i*) – *BC* (*j*)	14.78%	34.00%	<.001***	$\mu_i < \mu_j$, reject H_0	39.61%	28.58%	.005***	$\mu_i > \mu_j$, reject H_0
	FP&A (*i*) – *BC* (*j*)	38.33%	34.00%	.381	Retain H_0	27.86%	28.58%	.856	Retain H_0
RPA	*I* (*i*) – *F* (*j*)	3.17	2.94	.136	Retain H_0	2.07	2.07	1.000	Retain H_0
	I (*i*) – *T* (*j*)	3.17	1.91	<.001***	$\mu_i > \mu_j$, reject H_0	2.07	1.46	<.001***	$\mu_i > \mu_j$, reject H_0
	F (*i*) – *T* (*j*)	2.94	1.91	<.001***	$\mu_i > \mu_j$, reject H_0	2.07	1.46	<.001***	$\mu_i > \mu_j$, reject H_0
ContAcc	*I* (*i*) – *F* (*j*)	3.31	2.93	.013**	$\mu_i > \mu_j$, reject H_0	1.88	1.81	.645	Retain H_0
	I (*i*) – *T* (*j*)	3.31	2.41	<.001***	$\mu_i > \mu_j$, reject H_0	1.88	1.37	<.001***	$\mu_i > \mu_j$, reject H_0
	F (*i*) – *T* (*j*)	2.93	2.41	.006***	$\mu_i > \mu_j$, reject H_0	1.81	1.37	<.001***	$\mu_i > \mu_j$, reject H_0
AI-ML	*I* (*i*) – *F* (*j*)	2.83	2.64	.165	Retain H_0	1.54	1.23	.002***	$\mu_i > \mu_j$, reject H_0
	I (*i*) – *T* (*j*)	2.83	1.81	<.001***	$\mu_i > \mu_j$, reject H_0	1.54	1.12	<.001***	$\mu_i > \mu_j$, reject H_0
	F (*i*) – *T* (*j*)	2.64	1.81	<.001***	$\mu_i > \mu_j$, reject H_0	1.23	1.12	.152	Retain H_0
BigData	*I* (*i*) – *F* (*j*)	3.30	2.96	.003***	$\mu_i > \mu_j$, reject H_0	1.91	1.73	.121	Retain H_0
	I (*i*) – *T* (*j*)	3.30	2.16	<.001***	$\mu_i > \mu_j$, reject H_0	1.91	1.34	<.001***	$\mu_i > \mu_j$, reject H_0
	F (*i*) – *T* (*j*)	2.96	2.16	<.001***	$\mu_i > \mu_j$, reject H_0	1.73	1.34	<.001***	$\mu_i > \mu_j$, reject H_0
Analytics	*I* (*i*) – *F* (*j*)	3.49	2.98	<.001***	$\mu_i > \mu_j$, reject H_0	2.26	1.98	.020**	$\mu_i > \mu_j$, reject H_0
	I (*i*) – *T* (*j*)	3.49	2.32	<.001***	$\mu_i > \mu_j$, reject H_0	2.26	1.60	<.001***	$\mu_i > \mu_j$, reject H_0
	F (*i*) – *T* (*j*)	2.98	2.32	<.001***	$\mu_i > \mu_j$, reject H_0	1.98	1.60	<.005***	$\mu_i > \mu_j$, reject H_0
Visual	*I* (*i*) – *F* (*j*)	3.24	2.81	<.001***	$\mu_i > \mu_j$, reject H_0	2.50	2.03	<.001***	$\mu_i > \mu_j$, reject H_0
	I (*i*) – *T* (*j*)	3.24	2.24	<.001***	$\mu_i > \mu_j$, reject H_0	2.50	1.58	<.001***	$\mu_i > \mu_j$, reject H_0
	F (*i*) – *T* (*j*)	2.81	2.24	<.001***	$\mu_i > \mu_j$, reject H_0	2.03	1.58	<.001***	$\mu_i > \mu_j$, reject H_0
Block-chain	*I* (*i*) – *F* (*j*)	2.69	2.31	<.001***	$\mu_i > \mu_j$, reject H_0	1.43	1.30	.276	Retain H_0
	I (*i*) – *T* (*j*)	2.69	1.77	<.001***	$\mu_i > \mu_j$, reject H_0	1.43	1.05	<.001***	$\mu_i > \mu_j$, reject H_0
	F (*i*) – *T* (*j*)	2.31	1.77	<.001***	$\mu_i > \mu_j$, reject H_0	1.30	1.05	.009***	$\mu_i > \mu_j$, reject H_0
IoT	*I* (*i*) – *F* (*j*)	3.03	2.64	.002***	$\mu_i > \mu_j$, reject H_0	1.83	1.68	.144	Retain H_0
	I (*i*) – *T* (*j*)	3.03	1.97	<.001***	$\mu_i > \mu_j$, reject H_0	1.83	1.38	.002***	$\mu_i > \mu_j$, reject H_0
	F (*i*) – *T* (*j*)	2.64	1.97	<.001***	$\mu_i > \mu_j$, reject H_0	1.68	1.38	.002***	$\mu_i > \mu_j$, reject H_0

*,**,*** denote 10%, 5% and 1% significance level, respectively
†: the reported values for p result from applying the Wilcoxon signed rank test for paired observations
‡: *I*: *Inspirational*; *F*: *Functional*; *T*: *Technical*

collect, process, and analyze data to obtain meaningful information in support of decision making. "Data visualization, enterprise business services, cloud infrastructures, database dashboard metrics, web-based collaborations and extensible business reporting protocols" are changing the management accountant's profession.[34]

With all these changes, it's important to have a vision for how digitization, datafication, and transformation will impact the finance function. This vision will help the finance function adequately prepare its digital transformation and identify the paradigm shifts CFOs will be confronted with in the coming years. The consequences will affect the core responsibilities of the finance function in general and the management accountant in particular.

In the case of datafication, management accountants will need adequate knowledge and experience of data analytics and their relevance for decision making. This will require a vision to develop analytics in the right direction, which is not only important for the finance function, but it may well define its very existence.

Failure to benefit from Big Data will lead a company to be outcompeted. To take advantage, companies will need to remove two obstacles:[35]

- Poor cooperation between the management accountant and the IS/IT specialist.[36] This person will lack specific and in-depth knowledge of the business and its economics, hampering him or her from responding to the requested support for decision making. The management accountant could bridge this gap. The management accountant has affinity with "extracting, processing, analyzing and reporting based on large datasets that are widely distributed throughout the organization."
- Insufficient expertise in data analytics, resulting in an organization making no, too little, or incorrect use of the available data. As the custodian of business information, the management accountant is the person primarily responsible for removing this obstacle. Obviously, this also assumes adequate training.

The management accountant is expected to play a pivotal role in removing both obstacles and therefore understands:

- Management's information requirements;
- The technical impact of converting data into information using analytics;
- The general logical and technical IT infrastructure and, in particular, the data infrastructure; and
- The internal controls required for data security and data integrity.

Management accountants will also need to be familiar with value creation, i.e., to think creatively about the use of Big Data, ask questions that lead to insights, look for creative ways to interpret business issues, find creative solutions to problems, and advise management on new data-driven business models.[37] At the same time, the management accountant needs to have a critical attitude and challenge even deep-rooted standpoints. This is because they need to prevent errors (bias) in data interpretation and ensure that implicit knowledge and experience are not neglected when conclusions are drawn from data analyses.[38]

RPA and machine learning are becoming standard for transaction processing. Management accountants must not only be familiar with these technologies, but they also need to understand what is required to establish rules and risk profiles for controlling the robots. More than ever, this requires a capacity to combine knowledge of accounting with knowledge of automated systems and processes and an understanding of the complex process rules that make robots work.

Blockchain applications are currently being tested at the local level and in pilots. The effects on economic transaction processing will not become apparent for a few years to come, yet the expected effects can be radical. This is precisely why now is the time for management accountants to learn about the strengths, weaknesses, requirements, and potential consequences of blockchain to record economic transactions. Only then can we expect management accountants to support the finance function during the radical transformation that the successful organizations of tomorrow have already started implementing.[39]

Our framework and survey results can serve as a starting point to prepare for and decide on implementing the building blocks of digitization, datafication, and transformation. The survey illuminates how senior professionals of leading organizations see their role in the transformation process and therefore provide perspec-

tive for the personal development agendas of management accountants. The framework can serve as a starting point for structuring the self-assessment and developing the digital agenda of the finance function. ■

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ENDNOTES

1 Data can take many forms, such as figures, codes, letters, texts, images, sounds, smells, etc.
2 On the one hand, due to existing IT capacity limitations (mainly to integrated applications and to a lesser extent to function-specific partial applications) and high-energy costs, and on the other hand, due to still unresolved issues, such as the far-reaching transparency for members of the blockchain, the necessity of also providing information to nonmember stakeholders, and governance requirements.
3 For the sake of simplicity, cloud applications are not included here; it does not matter for RPA whether the robot is installed on a company's own servers or in the cloud.
4 ACCA, *The robots are coming!* August 2015, bit.ly/34vc01D.
5 Isaac Tucker, "The Blueprint for Continuous Accounting," *Strategic Finance*, May 2017, pp. 40-49; Isaac Tucker, "Are You Ready for Your Robots?" *Strategic Finance*, November 2017, pp. 48-53.
6 The only interventions required concern exceptions that the computer is unable to process. With learning systems and AI, however, the number of exceptions is declining. The implementation and application of algorithms introduce risks that are partly unknown and require new control measures. Cathy O'Neil, *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*, Crown, New York, N.Y., 2016.
7 Tucker, May 2017.
8 IoT technologies include active and passive RFID, wireless sensor networks (WSN), middleware (a/o GSN), cloud computing (a/o IaaS and SaaS), and IoT application software (e.g., monitoring applications).
9 Linnet Taylor and Dennis Broeders, "In the Name of Development: Power, Profit and the Datafication of the Global South," *Geoforum*, August 2015, pp. 229-237.
10 H. Thomas Johnson and Robert S. Kaplan, *Relevance Lost: The Rise and Fall of Management Accounting*, Harvard Business School Press, Boston, Mass., 1987.
11 This does not preclude the use of carefully considered information intervals to stay up to date with trends. On the contrary, periodic information is still very relevant for assessing plans and preparing forecasts.
12 We follow Gartner (2016) and use the following definition for Big Data: high-volume, high-velocity, and/or high-variety information assets that demand cost-effective, innovative forms of information processing enabling enhanced insight, decision making, and process automation.
13 Deb Sledgianowski, Mohamed Gomaa, and Christine Tan, "Toward Integration of Big Data, Technology and Information Systems Competencies into the Accounting Curriculum," *Journal of Accounting Education*, March 2017, pp. 81-93.
14 This forces organizations to use data lakes and related applications such as HADOOP, which enables them to process extremely large amounts of unstructured data spread across multiple computers and/or databases. In this sense, HADOOP can be used as a platform to conduct analyses of this data. Uday S. Murthy and Guido L. Geerts, "An REA Ontology-Based Model for Mapping Big Data to Accounting Information Systems Elements," *Journal of Information Systems*, May 2017, pp. 45-61.
15 With statistical analyses for descriptive, explanatory, predictive, and prescriptive analytics, we refer to, amongst others, parametric and nonparametric tests for comparing means, variances, and distributions, time series modelling, regression analyses, factor analyses, structural equation modelling, Monte Carlo simulation, Markov simulation, linear and nonlinear deterministic, and probabilistic programming. See, for instance, the overviews in the following articles: Galit Shmueli and Otto R. Koppius, "Predictive Analytics in Information Systems Research," *MIS Quarterly*, September 2011, pp. 553-572; and Atanu Basu, "Five Pillars of Prescriptive Analytics Success," *Analytics*, March/April 2013, pp. 8-12.
16 The data for carrying out predictive and prescriptive analyses in support of forecasts and plans are mainly obtained by combining real-time access to relevant financial data with Big Data analyses of insights and knowledge that are relevant to decision making.
17 In many organizations the finance function is expected to take care of the reliability of data used for performance management and reporting purposes. This requires the use of modern technology for assessing and assuring the reliability of the underlying internal and external data.
18 Marco Iansiti and Karim R. Lakhani, "The Truth about Blockchain," *Harvard Business Review*, January-February 2017, pp. 118-127.
19 While we still mainly associate blockchain with cryptocurrencies such as bitcoin, blockchain is now also being used in proof-of-concept studies for other business activities that have nothing to do with cryptocurrency. Jun Dai and Miklos A. Vasarhelyi, "Towards Blockchain-Based Accounting and Assurance," *Journal of Information Systems*, Fall 2017, pp. 5-21.
20 A smart contract is a software application that is used in a blockchain to rapidly verify and process transactions autonomously based on pre-agreed and specified rules. A more advanced application of a smart contract can autonomously initiate and fulfill contract terms such as payment deadlines.

21 In combination with IoT applications, blockchain and smart contracts can offer solutions for the autonomous management and processing of contracts between parties involving physical products and services. Dai and Vasarhelyi, 2017.

22 Dai and Vasarhelyi, 2017.

23 Michael E. Porter and James E. Heppelmann, "How Smart, Connected Products are Transforming Companies," *Harvard Business Review*, October 2015, pp. 96-114.

24 Financial Executive Research Foundation and Deloitte, "Blockchain and the Future of Financial Reporting," 2017, www.financialexecutives.org/Research/News/2017/Blockchain-and-the-Future-of-Financial-Reporti-(1).aspx.

25 Predictions vary between three to five years and 10 years. See, for instance, Genpact, "Re-imagining the Future of Finance with Blockchain," October 2017, www.genpact.com/insight/point-of-view/re-imagining-the-future-of-finance-with-blockchain. Genpact is a professional services company that executes accounting processes for organizations. Cesar Bacani, "The Death of Accounting and Auditing," *CFO Innovation*, March 20, 2017, www.cfoinnovation.com/story/12767/death-accounting-and-auditing-and-what-do-about-it. The speed of adoption will differ depending on the business sector. For example, Iansiti and Lakhani (2017) submit that the financial services sector has already come a long way, while manufacturing companies still have a long road ahead of them.

26 Thompson points out that some businesses have already started implementing smart contracts, real-time transaction and payment processing, digital registry verification, digital identity verification, and digital currencies for payments. Thomas Thompson, "Bots are the Future, but They're Not a Panacea," *Financial Executives*, November 9, 2017, daily.financialexecutives.org/bots-future-theyre-not-panacea.

27 Iansiti and Lakhani, 2017.

28 This development will in any case force us to reconsider primary data recording, delegation of decision-making rights, and segregation of duties in organizations.

29 The source of an administrative organization, and particularly its internal controls, lies in the delegation of decision-making rights within the organization. When the smart contract executes a decision in a blockchain, it is assumed that protocols have been established that incorporate decision-making rights in a way that they can be verified when the smart contract is executed. In this context, protocols can be considered as simplified authorization tables. This clearly necessitates soundly designed and verifiable smart contracts, whereby the role of the finance function will be extremely important. Furthermore, the increasing use of internet technology will demand more attention for internal control activities in digital environments (e.g., cybersecurity).

30 The real-time survey took place on June 14, 2018, at the Ernst & Young office in Amsterdam.

31 We used the minimum sample size formulas for continuous and discrete data in Doane and Seward and applied the adjustment factor for small samples. David P. Doane and Lori E. Seward, *Applied Statistics in Business & Economics*, McGraw-Hill Irwin, New York, N.Y., 2017. Besides, we tested the reliability, or internal consistency, of the applied scales using Cronbach's α. Cronbach's α amounts to 0.803 for questions 3 to 10, while Cronbach's *a* based on standardized items for questions 1 to 10 amounts to 0.798. As questions 3 to 10 use a different scale than questions 1 and 2, we report both values for Cronbach's *a*. Values of 0.80 for Cronbach's *a* are considered to represent a good level of internal consistency (e.g., Robert F. DeVellis, *Scale Development: Theory and Applications*, Sage, Los Angeles, Calif., 2012).

32 Based on the (not tabulated) outcomes of the Shapiro-Wilk test, we reject the null-hypothesis of a normal distribution for all variables except for the difference between *FFdriver_BC_2022* and *FFdriver_BC_2018*. Therefore, we applied the non-parametric Wilcoxon signed-rank test for comparing the paired observations (instead of the parametric paired t-test in the case of normally distributed responses) and testing the significance of differences. As the values for the kurtosis and the skewness in Table 1 would support retaining the null-hypothesis of normally distributed data for more variables, we also applied the paired t-test as a robustness check and found similar outcomes.

33 Most participants did not consider the developments in the area of financial analytics as mere hype, as 88.4% (74.4%) weighted the extent of hype below 50% (40%). Furthermore, the mean score of the corresponding variable (FadClass) is 3.4, as reported in Table 1. This corresponds with a score closer to the range between 20% and 30% than to the range from 30% to 40%. The median is 3.0, which represents the range between 20% and 30%. We also analyzed impacts on the scores of the other variables and found that FadClass is only weakly correlated with just a few other variables.

34 Not surprisingly, the Association to Advance Collegiate Schools of Business International declared the following in Accounting Standard 7 (2016): "…accounting degree programmes include learning experiences that develop skills and knowledge related to the integration of information technology in Accounting and Business. Included here is data creation, data sharing, data mining, data reporting, and storage within and across organizations."

35 Joshua G. Coyne, Emily M. Coyne, and Kenton B. Walker, "Accountants and Tech: A Game Changer?" *Strategic Finance*, March 2017, pp. 40-47.

36 This article does not take into account the existence of legacy systems that often form a bottleneck to change. It will be clear why the IT strategy will have to be harmonized with the business strategy for the same reason.

37 Value can be expressed in several ways but is important as a leading criterion for judging desired, expected, and realized outcomes of business activities.

38 Esperanza Huerta and Scott Jensen, "An Accounting Information System Perspective on Data Analytics and Big Data," *Journal of Information Systems*, Fall 2017, pp. 101-114; Earl McKinney Jr., Charles J. Yoos II, and Ken Snead, "The Need for 'Skeptical' Accountants in the Era of Big Data," *Journal of Accounting Education*, March 2017, pp. 63-80; Alex S. Wilner, "Cybersecurity and Its Discontents: Artificial Intelligence, the Internet of Things, and Digital Misinformation," *International Journal*, July 2018, pp. 308-316.

39 Porter and Heppelmann, 2015.